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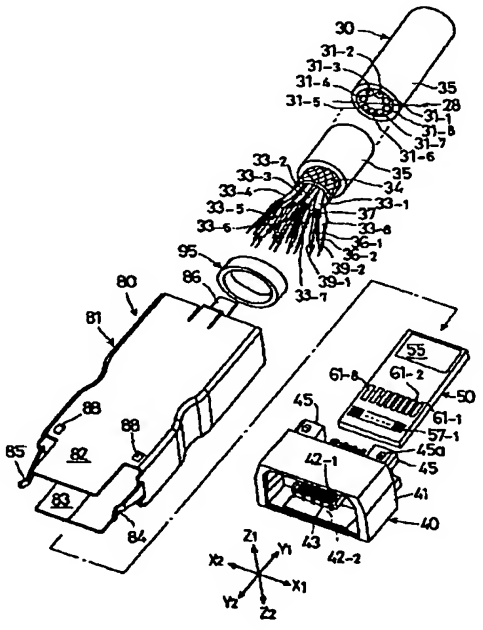
(54)【発明の名称】　ケーブル付き平衡伝送用コネクタ

(57)【要約】
【課題】　本発明は平衡伝送に適したケーブル付き平衡伝送用コネクタを提供することを課題とする。
【解決手段】平衡伝送用ケーブル３０の両端に平衡伝送用コネクタ１１、１２を有する。平衡伝送用コネクタ１１は、平衡伝送用プラグ４０と中継基板５０と平衡伝送用ケーブル３０の端部とよりなるサブ組立体１００を、シールドカバー８０が覆う構成である。平衡伝送用プラグ４０は、中継基板５０を弾性的に挟んだ状態で取り付けてある。中継基板５０は多層構造である。第１の信号コンタクト４２－１から中継基板５０を経て、更に延びている電線３６－１を経て平衡伝送用ケーブル３０に到る長さと、第２の信号コンタクト４２－２から中継基板５０を経て、更に延びている電線３６－１を経て平衡伝送用ケーブル３０に到る長さとが等しくしてある。これによって、平衡伝送される＋信号と－信号との間のスキュウの発生が抑制される。

図１のケーブル付き平衡伝送用コネクタの分解斜視図



【特許請求の範囲】
【請求項１】　平衡伝送用ジャックに接続される平衡伝送用プラグをケーブルの端に有する構成のケーブル付き平衡伝送用コネクタであって、
中継する中継基板と、
該中継基板の一端に取り付けられた平衡伝送用プラグと、
該中継基板の他端に接続された平衡伝送用ケーブルと、
該中継基板、平衡伝送用プラグの中継基板への取り付け部分、ケーブルの中継基板への接続部分を覆うシールドカバーとよりなり、
上記平衡伝送用プラグの対をなす第１及び第２の信号コンタクトのうち第１の信号コンタクトから上記中継基板を経て上記平衡伝送用ケーブルに到る長さと、第２の信号コンタクトから上記中継基板を経て上記平衡伝送用ケーブルに到る長さとが等しくなるように構成したことを特徴とするケーブル付き平衡伝送用コネクタ。
【請求項２】　平衡伝送用ジャックに接続される平衡伝送用プラグをケーブルの端に有する構成のケーブル付き平衡伝送用コネクタであって、
中継する中継基板と、
該中継基板の一端に取り付けられた平衡伝送用プラグと、
端から複数の電線が延びて出ており、各電線が該中継基板の他端に接続された平衡伝送用ケーブルと、
該中継基板、平衡伝送用プラグの中継基板への取り付け部分、ケーブルの中継基板への接続部分を覆うシールドカバーとよりなり、
上記平衡伝送用プラグの対をなす第１及び第２の信号コンタクトのうち第１の信号コンタクトから上記中継基板を経て、更に延びている電線を経て上記平衡伝送用ケーブルに到る長さと、第２の信号コンタクトから上記中継基板を経て、更に延びている電線を経て平衡伝送用ケーブルに到る長さとが等しくなるように構成したことを特徴とするケーブル付き平衡伝送用コネクタ。
【請求項３】　平衡伝送用ジャックに接続される平衡伝送用プラグをケーブルの端に有する構成のケーブル付き平衡伝送用コネクタであって、
中継する中継基板と、
該中継基板の一端に取り付けられた平衡伝送用プラグと、
端から複数の電線が延びて出ており、各電線が該中継基板の他端に接続された平衡伝送用ケーブルと、
該中継基板、平衡伝送用プラグの中継基板への取り付け部分、ケーブルの中継基板への接続部分を覆うシールドカバーとよりなり、
上記平衡伝送用プラグは、合成樹脂製のハウジングと、このハウジング内に交互に並んでいるグランドコンタクトと対をなす信号コンタクトとよりなり、対をなす第１及び第２の信号コンタクトは、中継基板の端部を挟む形状の第１及び第２の信号コンタクト脚部を有し、該第１の信号コンタクト脚部の長さと第２の信号コンタクト脚部の長さとは等しい構成であり、
上記平衡伝送用ケーブルは、筒状の外被覆部と、この内側の筒状の電線用遮蔽部と、この外周側遮蔽部の内周面に沿って並んで配されている複数の電線と、円状に並んで配されている複数の電線の内側の部分を埋めている充填部とよりなり、各電線は、平衡信号伝送用の対をなす２本の導線とこれらを遮蔽する導線用遮蔽部を有する構成であり、
上記中継基板は、多層構造であり、一端側の表面と裏面とに、導線用遮蔽部が半田付けされるグランドランドを有し、他端側の表面と裏面とに、信号パッドが表面側の信号パッドと裏面側の信号パッドとが対をなす関係で並んでおり、且つ、該グランドランドと該信号パッドの間の、表面と裏面とに、電線の導線の端が半田付けされる対をなす導線用パッドを有し、且つ、内層を利用して、対をなす導線用パッドの一の導線用パッドと表面側の信号パッドをつなぐ第１の配線と、別の導線用パッドと裏面側の信号パッドをつなぐ第２の配線とを有し、該第１の配線の長さと第２の配線の長さとが等しい構成であり、
上記平衡伝送用プラグは、第１の信号コンタクト脚部と第２の信号コンタクト脚部とで中継基板をはさみ、且つ、グランドコンタクト脚部で中継基板をはさんで、第１の信号コンタクト脚部が表面側の信号パッドと半田付けされ、第２の信号コンタクト脚部が裏面側の信号パッドと半田付けされて、中継基板の端に固定してあり、
上記平衡伝送用ケーブルについては、端からから延びて出ている複数の電線が中継基板の表面側側と裏面側とに均等に分散されており、各電線について、対をなす２本の導線のうちの一の導線が一の導線用パッドに半田付けしてあり、別の導線が別の導線用パッドに半田付けしてあり、
上記シールドカバーは、一端側にシールド板部、他端側にシールド用腕部を有し、該シールド板部を上記平衡伝送用プラグのハウジング内に挿入されて、且つ該シールド用腕部を上記平衡伝送用ケーブルの電線用遮蔽部と接続されて取り付けてある構成としたことを特徴とするケーブル付き平衡伝送用コネクタ。
【請求項４】　合成樹脂製のハウジングと、このハウジング内に交互に並んでいるグランドコンタクトと対をなす信号コンタクトと、該ハウジングに対向して組み込まれた２つのシールド板とよりなり、
対をなす第１及び第２の信号コンタクトは、プリント基板の端部を挟む形状の第１及び第２の信号コンタクト脚部を有し、該第１の信号コンタクト脚部の長さと該第２の信号コンタクト脚部の長さとは等しく、
上記グランドコンタクトは、プリント基板の端部を挟む形状のグランドコンタクト脚部を有し、

上記シールド板は、プリント基板の端部を挟む形状の脚を有する構成としたことを特徴とする平衡伝送用プラグ。

【請求項５】　合成樹脂製のハウジングと、このハウジング内に交互に並んでいるグランドコンタクトと対をなす信号コンタクトと、該ハウジングに対向して組み込まれた２つのシールド部材とよりなり、

対をなす第１及び第２の信号コンタクトは、プリント基板の端部を挟む形状の第１及び第２の信号コンタクト脚部を有し、該第１の信号コンタクト脚部の長さと該第２の信号コンタクト脚部の長さとは等しく、

上記グランドコンタクトは、プリント基板の端部を挟む形状のグランドコンタクト脚部を有し、

上記シールド板は、該ハウジング内に挿入されるシールド板部と、該シールド板部が該ハウジング内に挿入された状態で、上記第１の信号コンタクト脚部、第２の信号コンタクト脚部、及びグランドコンタクト脚部を覆う覆い部とを有する構成としたことを特徴とする平衡伝送用プラグ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明はケーブル付き平衡伝送用コネクタに係り、特に、コンピュータと周辺機器との接続に使用されるケーブル付き平衡伝送用コネクタに関する。近年のパーソナルコンピュータやそのネットワークの発達に伴い、各システムは特に動画像の大量のデータを伝送することが求められている。動画像の大量のデータを伝送するためには、データを１Ｇｂｉｔ／秒以上の高速度で伝送する必要がある。

【０００２】従来は、伝送の方式としては、コストメリット等があるので不平衡伝送が広く採用されている。しかし、不平衡伝送はノイズの影響を受けやすいため、今後のの高速伝送では、ノイズに強い平衡伝送が採用されると考えられる。また、パーソナルコンピュータと周辺機器間を接続するのにケーブルの両端にコネクタを有するケーブル付きコネクタが使用される。このケーブル付きコネクタコネクタとして、平衡伝送に適したものを開発する必要がある。

【０００３】

【従来の技術】従来のパーソナルコンピュータと周辺機器間を接続するケーブル付きコネクタは、不平衡伝送に対応する構造のものであった。

【０００４】

【発明が解決しようとする課題】よって、従来のケーブル付きコネクタは、平衡伝送に適したものではなかった。そこで、本発明は上記課題を解決した平衡伝送用コネクタ装置を提供することを目的とする。

【０００５】

【課題を解決するための手段】請求項１の発明は、平衡伝送用ジャックに接続される平衡伝送用プラグをケーブルの端に有する構成のケーブル付き平衡伝送用コネクタであって、中継する中継基板と、該中継基板の一端に取り付けられた平衡伝送用プラグと、該中継基板の他端に接続された平衡伝送用ケーブルと、該中継基板、平衡伝送用プラグの中継基板への取り付け部分、ケーブルの中継基板への接続部分を覆うシールドカバーとよりなり、上記平衡伝送用プラグの対をなす第１及び第２の信号コンタクトのうち第１の信号コンタクトから上記中継基板を経て上記平衡伝送用ケーブルに到る長さと、第２の信号コンタクトから上記中継基板を経て上記平衡伝送用ケーブルに到る長さとが等しくなるように構成したものである。

【０００６】第１の信号コンタクトから上記中継基板を経て上記平衡伝送用ケーブルに到る長さと、第２の信号コンタクトから上記中継基板を経て上記平衡伝送用ケーブルに到る長さとを同じくすることによって、平衡伝送される＋信号と、この＋信号とは大きさが等しく逆向きの－信号との間で時間的なずれ（スキュー）が発生しないようになる。よって、１Ｇｂｉｔ／秒以上の高速度信号を信頼性良く伝送できる。

【０００７】請求項２の発明は、平衡伝送用ジャックに接続される平衡伝送用プラグをケーブルの端に有する構成のケーブル付き平衡伝送用コネクタであって、中継する中継基板と、該中継基板の一端に取り付けられた平衡伝送用プラグと、端から複数の電線が延びて出ており、各電線が該中継基板の他端に接続された平衡伝送用ケーブルと、該中継基板、平衡伝送用プラグの中継基板への取り付け部分、ケーブルの中継基板への接続部分を覆うシールドカバーとよりなり、上記平衡伝送用プラグの対をなす第１及び第２の信号コンタクトのうち第１の信号コンタクトから上記中継基板を経て、更に延びている電線を経て上記平衡伝送用ケーブルに到る長さと、第２の信号コンタクトから上記中継基板を経て、更に延びている電線を経て平衡伝送用ケーブルに到る長さとが等しくなるように構成したものである。

【０００８】第１の信号コンタクトから上記中継基板を経て、更に延びている電線を経て上記平衡伝送用ケーブルに到る長さと、第２の信号コンタクトから上記中継基板を経て、更に延びている電線を経て平衡伝送用ケーブルに到る長さとが同じくすることによって、平衡伝送される＋信号と、この＋信号とは大きさが等しく逆向きの－信号との間でスキューが発生しないようになると共に、平衡伝送される信号と別の平衡伝送される信号との間の伝送のずれを抑えることが可能となる。

【０００９】請求項３の発明は、平衡伝送用ジャックに接続される平衡伝送用プラグをケーブルの端に有する構成のケーブル付き平衡伝送用コネクタであって、中継する中継基板と、該中継基板の一端に取り付けられた平衡伝送用プラグと、端から複数の電線が延びて出ており、各電線が該中継基板の他端に接続された平衡伝送用ケー

ブルと、該中継基板、平衡伝送用プラグの中継基板への取り付け部分、ケーブルの中継基板への接続部分を覆うシールドカバーとよりなり、上記平衡伝送用プラグは、合成樹脂製のハウジングと、このハウジング内に交互に並んでいるグランドコンタクトと対をなす信号コンタクトとよりなり、対をなす第１及び第２の信号コンタクトは、中継基板の端部を挟む形状の第１及び第２の信号コンタクト脚部を有し、該第１の信号コンタクト脚部の長さと第２の信号コンタクト脚部の長さとは等しい構成であり、上記平衡伝送用ケーブルは、筒状の外被覆部と、この内側の筒状の電線用遮蔽部と、この外周側遮蔽部の内周面に沿って並んで配されている複数の電線と、円状に並んで配されている複数の電線の内側の部分を埋めている充填部とよりなり、各電線は、平衡信号伝送用の対をなす２本の導線とこれらを遮蔽する導線用遮蔽部を有する構成であり、上記中継基板は、多層構造であり、一端側の表面と裏面とに、導線用遮蔽部が半田付けされるグランドランドを有し、他端側の表面と裏面とに、信号パッドが表面側の信号パッドと裏面側の信号パッドとが対をなす関係で並んでおり、且つ、該グランドランドと該信号パッドの間の、表面と裏面とに、電線の導線の端が半田付けされる対をなす導線用パッドを有し、且つ、内層を利用して、対をなす導線用パッドの一の導線用パッドと表面側の信号パッドをつなぐ第１の配線と、別の導線用パッドと裏面側の信号パッドをつなぐ第２の配線とを有し、該第１の配線の長さと第２の配線の長さとが等しい構成であり、上記平衡伝送用プラグは、第１の信号コンタクト脚部と第２の信号コンタクト脚部とで中継基板をはさみ、且つ、グランドコンタクト脚部で中継基板をはさんで、第１の信号コンタクト脚部が表面側の信号パッドと半田付けされ、第２の信号コンタクト脚部が裏面側の信号パッドと半田付けされて、中継基板の端に固定してあり、上記平衡伝送用ケーブルについては、端からから延びて出ている複数の電線が中継基板の表面側側と裏面側とに均等に分散されており、各電線について、対をなす２本の導線のうちの一の導線が一の導線用パッドに半田付けしてあり、別の導線が別の導線用パッドに半田付けしてあり、上記シールドカバーは、一端側にシールド板部、他端側にシールド用腕部を有し、該シールド板部を上記平衡伝送用プラグのハウジング内に挿入されて、且つ該シールド用腕部を上記平衡伝送用ケーブルの電線用遮蔽部と接続されて取り付けある構成としたものである。

【００１０】中継基板は、多層構造であり、第１の配線及び第２の配線は内層を利用して形成してあるため、第１の配線の長さと第２の配線の長さとを同じにすることが可能である。また、平衡伝送用ケーブルの端から延びて出ている複数の電線が、円状に並んで配されており、且つ、中継基板の表面側側と裏面側とに均等に分散されているため、平衡伝送用ケーブルの端から延びて出ている各電線の長さが等しくなる。

【００１１】請求項４の発明は、合成樹脂製のハウジングと、このハウジング内に交互に並んでいるグランドコンタクトと対をなす信号コンタクトと、該ハウジングに対向して組み込まれた２つのシールド板とよりなり、対をなす第１及び第２の信号コンタクトは、プリント基板の端部を挟む形状の第１及び第２の信号コンタクト脚部を有し、該第１の信号コンタクト脚部の長さと該第２の信号コンタクト脚部の長さとは等しく、上記グランドコンタクトは、プリント基板の端部を挟む形状のグランドコンタクト脚部を有し、上記シールド板は、プリント基板の端部を挟む形状の脚を有する構成としたものである。

【００１２】対をなす第１及び第２の信号コンタクトがプリント基板の端部を挟む形状の第１及び第２の信号コンタクト脚部を有する構成は、平衡伝送用プラグを、その中心線上にプリント基板が位置する関係で、プリント基板の端に実装することを可能とする。請求項５の発明は、合成樹脂製のハウジングと、このハウジング内に交互に並んでいるグランドコンタクトと対をなす信号コンタクトと、該ハウジングに対向して組み込まれた２つのシールド部材とよりなり、対をなす第１及び第２の信号コンタクトは、プリント基板の端部を挟む形状の第１及び第２の信号コンタクト脚部を有し、該第１の信号コンタクト脚部の長さと該第２の信号コンタクト脚部の長さとは等しく、上記グランドコンタクトは、プリント基板の端部を挟む形状のグランドコンタクト脚部を有し、上記シールド板は、該ハウジング内に挿入されるシールド板部と、該シールド板部が該ハウジング内に挿入された状態で、上記第１の信号コンタクト脚部、第２の信号コンタクト脚部、及びグランドコンタクト脚部を覆う覆い部とを有する構成としたものである。

【００１３】覆い部は、第１の信号コンタクト脚部、第２の信号コンタクト脚部、及びグランドコンタクト脚部が外部からの電磁ノイズによる影響を受けにくくする。

【００１４】

【発明の実施の形態】〔第１実施例〕図１は本発明の第１実施例のケーブル付き平衡伝送用コネクタ１０を示す。ケーブル付き平衡伝送用コネクタ１０は、平衡伝送用ケーブル３０の両端に平衡伝送用コネクタ１１、１２を有する構成であり、一端のコネクタ１１をパーソナルコンピュータの平衡伝送用ジャック２０に接続され、他端のコネクタ１２を周辺機器の平衡伝送用ジャックに接続されて使用され、パーソナルコンピュータと周辺機器との間を接続する。

【００１５】ケーブル付き平衡伝送用コネクタ１０は、図２に分解して併せて示すように、平衡伝送用ケーブル３０の端部と、平衡伝送用プラグ４０と、中継基板５０と、シールドカバー８０と、かしめリング９５とを有し、図３及び図４に示すように、サブ組立体１００をシ

ールドカバー６０が覆う構造である。サブ組立体１００は、中継基板５０のＹ１方向端に平衡伝送用プラグ４０が取り付けられ、Ｙ２方向端に平衡伝送用ケーブル３０が半田付けされて接続された構造である。

【００１６】次に上記の各部品について説明する。

① 平衡伝送用ジャック２０

図５に併せて示すように、平衡伝送用ジャック２０は、合成樹脂製の箱形状のハウジング２１内に、対をなす２つのジャック側信号コンタクト２２－１，２２－２と、グランドコンタクト２３とが、Ｘ１，Ｘ２方向上、交互に並んで組み込まれており、且つ、Ｙ１，Ｙ２方向の両面側に長方形状のシールド板２４、２５が組み込まれている構造である。この平衡伝送用ジャック２０は、パーソナルコンピュータ内のプリント基板２６に実装してある。信号コンタクト２２－１，２２－２は、プリント基板２６の信号パターンと電気的に接続してあり、グランドコンタクト２３及びシールド板２４、２５はプリント基板２６のグランドと電気的に接続してある。グランドコンタクト２３は、対をなす信号コンタクト２２－１，２２－２のＸ１方向への投影領域をカバーする大きさを有する。ハウジング２１のＸ１，Ｘ２方向上の端面には、コネクタ１０の一部が嵌合する凹部２７が形成してある。

【００１７】② 平衡伝送用プラグ４０

図５に併せて示すように、平衡伝送用プラグ４０は、合成樹脂製の箱形状のハウジング４１内に、対をなす第１、第２の信号コンタクト４２－１，４２－２と、グランドコンタクト４３とが、平衡伝送用ジャック２０に対応したピッチで交互に並んで組み込まれている構造である。グランドコンタクト４３は対をなす信号コンタクト４２－１，４２－２のＸ１方向への投影領域をカバーする大きさを有する。

【００１８】第１、第２の信号コンタクト４２－１，４２－２は、夫々ハウジング４１外に突き出た脚部４２－１ａ，４２－２ａを有する。脚部４２－１ａ，４２－２ａは、Ｖ字形状であり、平衡伝送用プラグ４０の中心線４４に関して対称であり、中継基板５０をはさみ込むことが可能である。脚部４２－１ａの長さと脚部４２－２ａの長さとは等しい。第１の信号コンタクト４２－１の端Ａ１から脚部４２－１ａの先端Ｂ１までの第１の信号コンタクト４２－１に沿う長さと、第２の信号コンタクト４２－２の端Ａ２から脚部４２－２ａの先端Ｂ２までの第２の信号コンタクト４２－２に沿う長さとは等しい。

【００１９】グランドコンタクト４３は、２つの脚部４３ａ、４３ｂを有する。脚部４３ａ、４３ｂは、Ｙ１方向へ向かうにつれて収斂するように延在しており、中継基板５０をはさみ込むことが可能である。また、図４に示すように、ハウジング４１は、四つのコーナ部からＹ１方向に突き出た腕４５を有する。各腕４５は、係止爪４５ａを有する。

【００２０】③ 平衡伝送用ケーブル３０

図６に併せて示すように、平衡伝送用ケーブル３０は、軸線に対して垂直の断面において、８本の電線３１－１～３１－８が円を形成するように並んで配されている構造である。平衡伝送用ケーブル３０は、８本の電線３１－１～３１－８が中央の電気絶縁性の充填部３２の回りに円を形成するように配され、押さえ巻き部３３によって保持され、これが電線をまとめて遮蔽する電線群用遮蔽網線３４で覆われ、更に筒状の電気絶縁性の外被覆部３５で覆われた構造である。外周側から順に、外被覆部３５、電線群用遮蔽網線３４、押さえ巻き部３３、８本の電線３１－１～３１－８、充填部３２を有する。８本の電線３１－１～３１－８が円状に並んでいるため、電線を平衡伝送用ケーブル３０の端から引き出して分けて接続する場合に、平衡伝送用ケーブル３０の端から引き出して分けた各電線の長さを等しくすることが可能となる。

【００２１】各電線３３－１～３３－８は、平衡信号伝送用の対をなす第１、第２の被覆導線３６－１、３６－２と、これを覆う導線用遮蔽網線３７と押さえ巻き部３８とよりなる。第１、第２の被覆導線３６－１、３６－２は、第１、第２の導線３９－１、３９－２と被覆部２９とよりなる。

④ 中継基板５０

図７（Ａ），（Ｂ），（Ｃ）に併せて示すように、中継基板５０は、Ｙ１，Ｙ２方向に長い長方形であり、表面層５１、裏面層５２、第１の内層５３、第２の内層５４とよりなる四層構造である。

【００２２】表面層５１及び裏面層５２のＹ１方向端側には、導線用遮蔽網線３７が半田付けされるためのグランドランド５５、５６が形成してある。表面層５１のＹ１方向端側には、信号パッドとグランドパッドとが信号パッド５７－１，グランドパッド５８－１、信号パッド５７－２，グランドパッド５８－２…の順で交互にＸ１，Ｘ２方向で並んでいる。裏面層５２のＹ１方向端側には、同じく、信号パッドとグランドパッドとが信号パッド５９－１，グランドパッド６０－１、信号パッド５９－２，グランドパッド６０－２…の順で交互にＸ１，Ｘ２方向で並んでいる。信号パッド５７－１と信号パッド５９－１とが対をなし、信号パッド５７－２と信号パッド５９－２とが対をなす。信号パッドは８対有る。グランドパッド５８－１、５８－２…はグランドランド５５と接続してあり、グランドパッド６０－１、６０－２…はグランドランド５６と接続してある。

【００２３】中継基板５０のＹ１，Ｙ２方向の略中央には、表面層５１に、２つで対をなす８つの導線用パッド６１－１，６１－２…６１－８がＸ１，Ｘ２方向で並んで形成してある。隣り合う２つの導線用パッド６１－１，６１－２が第１の対をなす。隣り合う２つの導線用

パッド６１－３，６１－４が第２の対をなす。同じく、裏面層５２に、２つで対をなす８つの導線用パッド６２－１，６２－２…がＸ１，Ｘ２方向で並んで形成してある。同じく、隣り合う２つの導線用パッド６２－１，６２－２が対をなす。

【００２４】対をなす導線用パッドと対をなす信号パッドとが、配線で接続されている。対をなす導線用パッド６１－１と対をなす信号パッド５７－１、５９－１との接続についてみる。導線用パッド６１－２と信号パッド５７－１との間が第１の配線６３で接続されている。第１の配線６３は、導線用パッド６１－２から第１の内層５３へ到るビア６４、ビア６４の下端に続く第１の内層５３上の配線パターン６５と、配線パターン６５に続く第１の内層５３から表面層５１へ到るビア６６、ビア６６の上端から信号パッド５７－１に到る配線パターン６７とよりなる。

【００２５】導線用パッド６１－１と信号パッド５９－１との間が第２の配線６８で接続されている。第２の配線６８は、導線用パッド６１－１から第２の内層５５へ到るビア６９、ビア６９の下端に続く第２の内層５４上の配線パターン７０と、配線パターン７０に続く第２の内層５４から裏面層５２へ到るビア７１、ビア７１の下端から信号パッド５９－１に到る配線パターン７２とよりなる。

【００２６】第１の内層５３と第２の内層５４との間の厚さｔは、０．１～０．２ｍｍと薄い。よって、第１の配線６３の長さと第２の配線６８の長さとは殆ど等しい。即ち、信号パッド５７－１の位置Ｃ１から導線用パッド６１－２の位置Ｄ１までの第１の配線６３に沿う長さと、信号パッド５９－１の位置Ｃ２から導線用パッド６１－１の位置Ｄ２までの第２の配線６８に沿う長さとは殆ど等しい。

【００２７】表面層５１の他の導線用パッド及び裏面層５２の導線用パッドも、上記と同じく他の対をなす信号パッドと接続してある。

⑤　シールドカバー８０

図２に示すように、シールドカバー８０は、金属板をプレス加工してＹ１，Ｙ２方向に長い中空の略四角柱形状としたものであり、中空の略四角柱形状の本体８１と、この本体８１のＹ２方向端のＺ１，Ｚ２方向の縁よりＹ２方向に張り出したシールド板部８２、８３と、同じく本体８１のＹ２方向端のＸ１，Ｘ２方向の縁よりＹ２方向に張り出したロック腕部８４、８５と、本体８１のＹ１方向端のＺ１，Ｚ２方向の縁よりＹ１方向に張り出たシールド用腕部８６、８７と、本体８１のＹ２方向端寄りに形成してある係合開口８８とよりなる構成である。

【００２８】次に、サブ組立体１００について説明する。図４に示すように、サブ組立体１００は、中継基板５０のＹ２方向端に平衡伝送用プラグ４０が取り付けられ、中継基板５０のＹ１方向端に平衡伝送用ケーブル３０が接続された構成である。平衡伝送用プラグ４０は、図３に示すように、第１、第２の信号コンタクト４２－１，４２－２のＶ字形状の脚部４２－１ａ，４２－２ａ、及びグランドコンタクト４３の２つの脚部４３ａ、４３ｂが、中継基板５０を弾性的に挟んだ状態で、且つ、脚部４２－１ａが信号パッド５７－１と、脚部４２－２ａが信号パッド５９－１と、脚部４３ａがグランドパッド５８－１と、脚部４３ａがグランドパッド６０－１と夫々半田付けされて取り付けられている。

【００２９】中継基板５０は、平衡伝送用プラグ４０の中心線４４の延長線上に位置している。平衡伝送用ケーブル３０の端は、図２に示すように処理してある。電線群用遮蔽網線３４が露出され、８本の電線３１－１～３１－８が引き出されている。各電線３３－１～３３－８は、導線用遮蔽網線３７が露出され、第１、第２の被覆導線３６－１、３６－２が引き出され、先端側の被覆部２９が剥離されて第１、第２の導線３９－１、３９－２が露出している。

【００３０】引き出されている８本の電線３１－１～３１－８は、平衡伝送用ケーブル３０の中心を通る水平面２８でもって４本の電線３１－１～３１－４と４本の電線３１－５～３１－８とに分けられ、４本の電線３１－１～３１－４は整列されて中継基板５０の表面層５１側に導かれており、４本の電線３１－５～３１－８は整列されて中継基板５０の裏面層５２側に導かれている。

【００３１】４本の電線３１－１～３１－４については、Ｘ１，Ｘ２方向に並んでおり、各導線用遮蔽網線３７がグランドランド５５に半田付けされて中継基板５０に接続してある。電線３１－１から延びている第１、第２の被覆導線３６－１、３６－２は、中継基板５０の裏面層５２に沿ってＹ２方向に延びており、第１の導線３９－１は導線用パッド６１－２と半田付けされており、第２の導線３９－２は導線用パッド６１－１と半田付けされている。他の電線３１－２～３１－４についても、上記の電線３１－１と同じく、被覆導線が整列されており、且つ半田付けされている。裏面側の４本の電線３１－５～３１－８についても、同じく、各導線用遮蔽網線３７がグランドランド５６と半田付けされて中継基板５０に接続してあり、被覆導線が整列されて、先端の導線が導線用パッド６１－２等と半田付けされている。

【００３２】ここで、第１、第２の被覆導線３６－１、３６－２はＹ１、Ｙ２方向に平行に延在しているため、第１の被覆導線３６－１の先端Ｅ１から導線用遮蔽網線３７の位置Ｆ１までの長さと第２の被覆導線３６－２の先端Ｅ２から導線用遮蔽網線３７の位置Ｆ２までの長さとは等しい。また、８本の電線３１－１～３１－８は円を形成するように並んで配されており、平衡伝送用ケーブル３０の中心を通る水平面２８でもって４本づつに分けられているため、各電線の３１－１～３１－８の外被覆部３５の端から引き出されている長さのばらつきは小

さく、即ち、外被覆部３５の端の位置Ｇから導線用遮蔽網線３７の位置Ｆ１，Ｆ２までの長さは略等しい。よって、全部の電線の３１－１～３１－８の第１、第２の被覆導線は等長である。

【００３３】上記のサブ組立体１００において、対をなす＋信号と－信号とが伝送される経路についてみてみる。図３を参照するに、＋信号が伝送される位置Ａ１から位置Ｇまでの経路の長さ、即ち、第１の信号コンタクト４２－１→第１の配線６３→第１の被覆導線３６－１→電線３１－１の長さと、－信号が伝送される位置Ａ２から位置Ｇまでの経路の長さ、即ち、第２の信号コンタクト４２－２→第２の配線６８→第２の被覆導線３６－２→電線３１－１の長さとは、実質上略等しく、両者の誤差は、信号伝送時間の許容誤差１００ｐｓ／ｍ以下を満足している値である。

【００３４】また、８本の電線３１－１～３１－８の各長さは、実質上略等しく、各電線３１－１～３１－８の長さの誤差は、信号伝送時間の許容誤差１５０ｐｓ／ｍ以下を満足している値である。なお、中継基板５０の端に平衡伝送用プラグを取り付ける場合には、所謂ライトアングルタイプの平衡伝送用プラグを実装するのが通常である。しかし、ライトアングルタイプの場合には、第１の信号コンタクトと第１の信号コンタクトとの長さにずれが生じしまい、上記の平衡伝送には不向きとなる。

【００３５】次に、サブ組立体１００に対するシールドカバー８０及びかしめリング９５の関係について説明する。サブ組立体１００にシールドカバー８０及びかしめリング９５が組みつけられて、平衡伝送用平衡伝送用コネクタ１１が完成する。図１及び図３に示すように、シールドカバー８０は、本体８１のＹ２方向端が四方の腕４５に嵌合し係合開口８８が係止爪４５ａと係合して平衡伝送用プラグ４０と結合してある。本体８１は、サブ組立体１００を囲んで覆っており、中継基板５０、平衡伝送用プラグ４０の中継基板５０への取り付け部分、平衡伝送用ケーブル３０の中継基板５０への接続部分を覆っている。

【００３６】シールド板部８２、８３は、箱形状のハウジング４１内に入り込んでおり、箱形状のハウジング４１のＺ１，Ｚ２方向上対向する内側面に位置している。ロック腕部８４、８５は、箱形状のハウジング４１内に入り込んでおり、箱形状のハウジング４１のＸ１，Ｘ２方向上対向する内側面に位置している。かしめリング９５は、Ｘ１，Ｘ２の両側をかしめてあり、シールド用腕部８６、８７が電線群用遮蔽網線３４に圧着してあり、本体８１のＹ１方向端が平衡伝送用ケーブル３０の端と固定してある。

【００３７】上記構成の平衡伝送用コネクタ１１は、ロック腕部８４、８５が凹部２７と嵌合して平衡伝送用ジャック２０と結合されて、平衡伝送用ジャック２０と接続されて使用される。ケーブル付き平衡伝送用コネクタ１０は、パーソナルコンピュータと周辺機器との間に、８本の平衡伝送経路を構成する。上記構成の平衡伝送用コネクタ１１及びケーブル付き平衡伝送用コネクタ１０は、以下の特徴及び効果を有する。

【００３８】（１）平衡伝送される信号間のスキューの発生を抑えることが可能な構造

＋信号が伝送される位置Ａ１から位置Ｇまでの経路の長さと、＋信号とは大きさが等しく逆向きの－信号が伝送される位置Ａ２から位置Ｇまでの経路の長さとが実質上等しい。よって、平衡伝送される＋信号と－信号とに、時間的なずれ（スキュー）は発生しない。よって、ケーブル付き平衡伝送用コネクタ１０は１Ｇｂｉｔ／秒以上の高速度信号を信頼性良く伝送できる。

【００３９】（２）平衡伝送される信号と別の平衡伝送される信号との間の伝送のずれを抑えることが可能な構造

８本の平衡伝送経路の夫々の長さが等しい。よって、８本の平衡伝送経路を平衡伝送される８種類の信号間での時間的なずれ（スキュー）も発生しない。よって、ケーブル付き平衡伝送用コネクタ１０は、８種類の１Ｇｂｉｔ／秒以上の高速度信号を信頼性良く伝送できる８チャンネルの伝送路を実現する。

【００４０】（３）ストリップライン構造

図８に示すように、Ｘ１，Ｘ２方向上隣合っている対をなす第１、第２の信号コンタクト４２－１，４２－２の間に、グランドコンタクト４３が存在している構成が、ストリップライン構造を構成している。よって、平衡伝送用コネクタ１１はＸ１，Ｘ２方向上隣合う信号コンタクト及び信号パッドを伝送される信号間でクロストークが発生することを効果的に制限することができる。

【００４１】（４）仮想のグランド平面

図８に示すように、平衡伝送時に対をなす第１、第２の信号コンタクト４２－１，４２－２の間に仮想のグランド平面１１０が形成される。仮想のグランド平面１１０が形成されることによって、第１の信号コンタクト４２－１を伝送される＋信号と、第２の信号コンタクト４２－２を伝送される－信号との間でクロストークが発生することが効果的に制限される。

【００４２】

（５）外部シールド箱形状のハウジング４１内に入り込んでいるシールド板部８２、８３は、第１、第２の信号コンタクト４２－１，４２－２をシールドしている。よって、第１、第２の信号コンタクト４２－１，４２－２を平衡伝送される＋信号及び－信号が平衡伝送用コネクタ１１の外部からの電磁波によって影響を受けることが制限される。

【００４３】シールド板部８２、８３は、シールドカバー８０の一部であり、特別に用意された部品ではない。よって、平衡伝送用コネクタ１１はこの分部品点数を少なく構成される。なお、図１中、平衡伝送用ケーブル３

０の他端の平衡伝送用コネクタ１２は、上記の平衡伝送用コネクタ１１と同じ構造である。

【００４４】次に、変形例等について説明する。

〔平衡伝送用ケーブル３０の変形例〕図９（Ａ），（Ｂ）は、図６に示す平衡伝送用ケーブル３０の変形例を示す。各図中、図６に示す構成部分と同じ構成部分には同一符号を付し、その説明は省略する。

【００４５】図９（Ａ）に示す平衡伝送用ケーブル３０Ａは、各電線３３Ａ－１～３３Ａ－８が、平衡信号伝送用の対をなす第１、第２の被覆導線３６－１、３６－２に加えて、ドイレインワイヤ２７を有する構造である。図９（Ｂ）に示す平衡伝送用ケーブル３０Ｂは、各電線３３Ｂ－１～３３Ｂ－８が、図６中の押さえ巻き部３８が省略された構造である。

【００４６】〔平衡伝送用プラグ４０の変形例〕図１０（Ａ），（Ｂ）及び図１１（Ａ），（Ｂ）は、図２及び図５に示す平衡伝送用平衡伝送用プラグ４０の変形例を示す。各図中、図２及び図５に示す構成部分と対応する構成部分には同一符号を付し、その説明は省略する。図１０（Ａ），（Ｂ）に示す平衡伝送用プラグ４０Ａは、シールド板１２０、１２１が箱形状のハウジング４１内の上側と下側とに組み込んである構成である。各シールド板１２０、１２１は、両側より突き出た脚１２０ａ、１２１ａを有する。上側シールド板１２０の脚１２０ａと下側シールド板１２１の脚１２１ａとは、Ｙ１方向へ向かうにつれて収斂するように延在している。

【００４７】平衡伝送用プラグ４０Ａは、プリント板１２５の端部に、第１、第２の信号コンタクト４２－１，４２－２のＶ字形状の脚部４２－１ａ，４２－２ａ、及びグランドコンタクト４３の２つの脚部４３ａ、４３ｂ、及び上側シールド板１２０の脚１２０ａと下側シールド板１２１の脚１２１ａとが、プリント板１２５を弾性的に挟んだ状態で、且つ、対応するパッドと半田付けされて取り付けられる。

【００４８】図１１（Ａ），（Ｂ）に示す平衡伝送用プラグ４０Ｂは、上記のシールド板１２０，１２１に代えてシールド部材１３０，１３１が組み込まれる構成である。シールド部材１３０，１３１は、シールド板部１３０ａ，１３１ａと覆部１３０ｂ，１３１ｂとよりなる。覆部１３０ｂは、底部１３０ｃと両側の側板部１３０ｄとよりなる。覆部１３１ｂも同じ構成である。このシールド部材１３０，１３１は、平衡伝送用プラグ４０Ｂが、プリント板１２５の端部に実装された後に、シールド板部１３０ａ，１３１ａを箱形状のハウジング４１内にＹ２方向に圧入されて取り付けられ、覆部１３０ｂ，１３１ｂが、第１、第２の信号コンタクト４２－１，４２－２のＶ字形状の脚部４２－１ａ，４２－２ａ、及びグランドコンタクト４３の２つの脚部４３ａ、４３ｂを覆って、外部からの電磁ノイズによる影響が受けにくくなっている。

【００４９】

【発明の効果】以上説明したように、請求項１の発明によれば、第１の信号コンタクトから中継基板を経て平衡伝送用ケーブルに到る長さと、第２の信号コンタクトから中継基板を経て上記平衡伝送用ケーブルに到る長さとを等しくした構成であるため、平衡伝送される＋信号と、この＋信号とは大きさが等しく逆向きの－信号との間で時間的なずれ（スキュー）が発生しないように出来、よって、１Ｇｂｉｔ／秒以上の高速度信号を信頼性良く伝送することが出来る。また、平衡伝送される信号と別の平衡伝送される信号との間の伝送のずれを抑えることが出来る。

【００５０】請求項２の発明によれば、第１の信号コンタクトから中継基板を経て、更に延びている電線を経て平衡伝送用ケーブルに到る長さと、第２の信号コンタクトから中継基板を経て、更に延びている電線を経て平衡伝送用ケーブルに到る長さとを等しくした構成であるため、平衡伝送される＋信号と－信号との間でスキューが発生しないように出来、よって、１Ｇｂｉｔ／秒以上の高速度信号を信頼性良く伝送することが出来る。また、平衡伝送される信号と別の平衡伝送される信号との間の伝送のずれを抑えることが出来る。

【００５１】請求項３の発明によれば、中継基板は、多層構造であり、第１の配線及び第２の配線は内層を利用して形成してあるため、第１の配線の長さと第２の配線の長さとを同じにすることが出来る。また、平衡伝送用ケーブルの端から延びて出ている複数の電線が、円状に並んで配されており、且つ、中継基板の表面側と裏面側とに均等に分散されているため、平衡伝送用ケーブルの端から延びて出ている各電線の長さを等しく出来る。よって、平衡伝送される＋信号と－信号との間でスキューが発生しないように出来、よって、１Ｇｂｉｔ／秒以上の高速度信号を信頼性良く伝送することが出来る。また、平衡伝送される信号と別の平衡伝送される信号との間の伝送のずれを抑えることが出来る。

【００５２】また、シールド板部は、シールドカバーの一部であり、特別に用意された部品ではない。よって、平衡伝送用コネクタをこの分部品点数を少なく構成出来る。請求項４の発明によれば、対をなす第１及び第２の信号コンタクトがプリント基板の端部を挟む形状の第１及び第２の信号コンタクト脚部を有する構成であるため、平衡伝送用プラグを、その中心線上にプリント基板が位置する関係で、プリント基板の端に実装することが出来る。このように実装することによって、平衡伝送される＋信号と－信号との間でスキューが発生しないように出来る平衡伝送用プラグを実現することが出来る。

【００５３】請求項５の発明によれば、請求項４の発明による効果と同じ効果に加えて、覆い部によって、第１の信号コンタクト脚部、第２の信号コンタクト脚部、及びグランドコンタクト脚部が外部からの電磁ノイズによ

る影響を受けにくく出来るという効果を有する。

【図面の簡単な説明】

【図１】本発明の第１実施例になるケーブル付き平衡伝送用コネクタを示す図である。

【図２】図１のケーブル付き平衡伝送用コネクタ分解斜視図である。

【図３】図１中、ＩＩＩ－ＩＩＩ線に沿う断面図である。

【図４】プラグと中継基板とケーブルとよりなるサブ組立体を示す図である。

【図５】平衡伝送用ジャックと平衡伝送用プラグとを対応させて示す図である。

【図６】平衡伝送用ケーブルの断面図である。

【図７】中継基板の構造を示す図である。

【図８】平衡伝送用コネクタの構造を示す図である。

【図９】平衡伝送用ケーブルの変形例を示す図である。

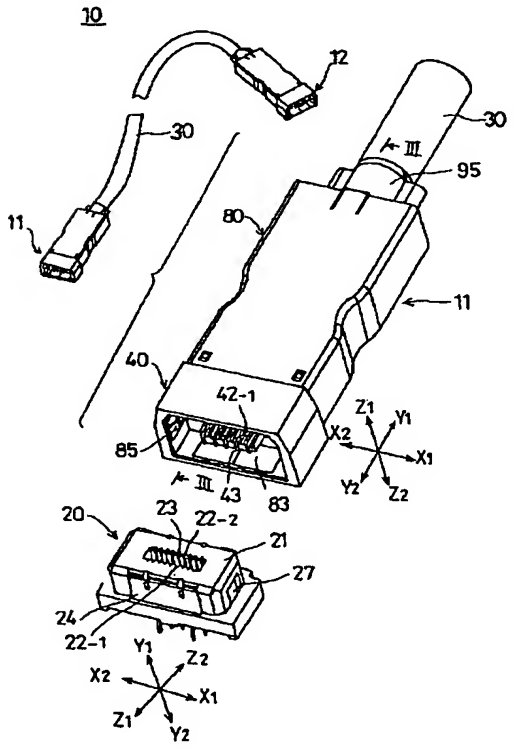
【図１０】平衡伝送用プラグの第１の変形例を示す図である。

【図１１】平衡伝送用プラグの第２の変形例を示す図である。

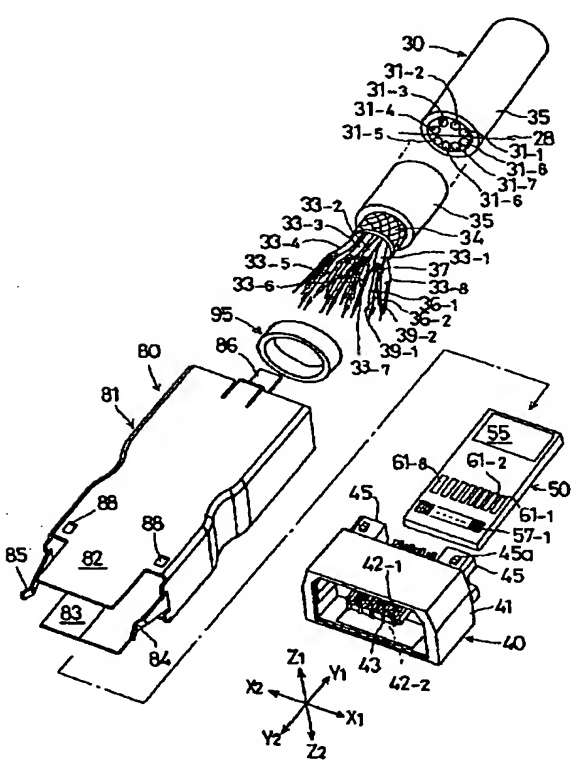
【符号の説明】

１０　ケーブル付き平衡伝送用コネクタ
１１、１２　平衡伝送用コネクタ
２０　平衡伝送用ジャック
３０，３０Ａ，３０Ｂ　平衡伝送用ケーブル
４０、４０Ａ，４０Ｂ　平衡伝送用プラグ
５０　中継基板
８０　シールドカバー
９５　かしめリング
１００　サブ組立体
１１０　仮想のグランド平面

【図１】

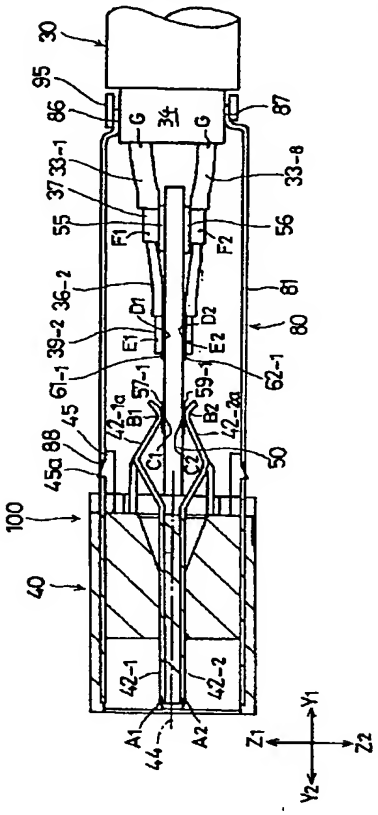


【図２】



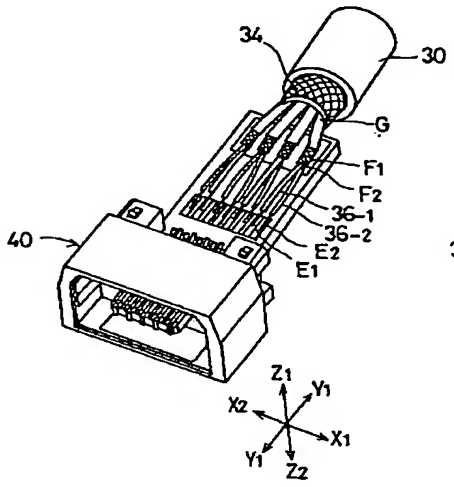
【図3】

図1中、III-IIIに沿う断面図



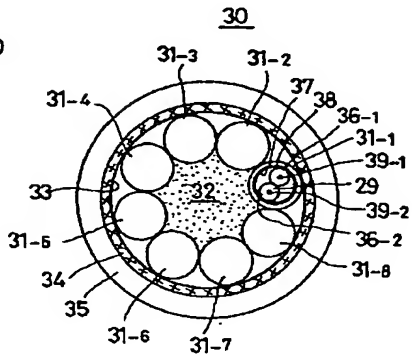
【図4】

プラグと中継基板とケーブルとよりなるサブ組立体を示す図



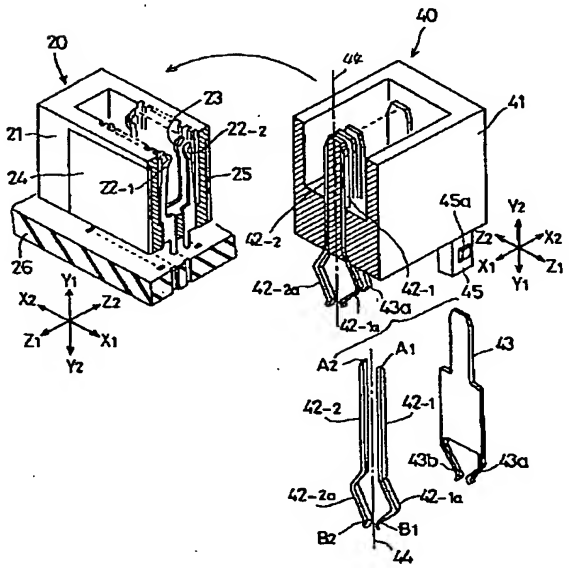
【図6】

平衡伝送用ケーブルの断面図



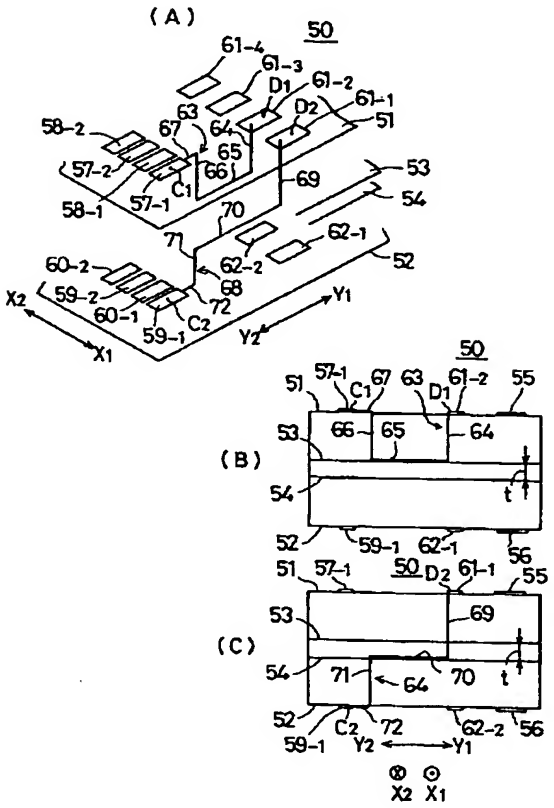
【図5】

平衡伝送用ジャックと平衡伝送用プラグとを対応させて示す図



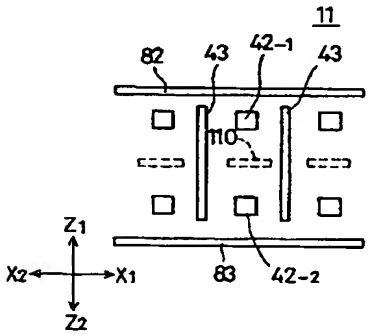
【図7】

中継基板の構造を示す図



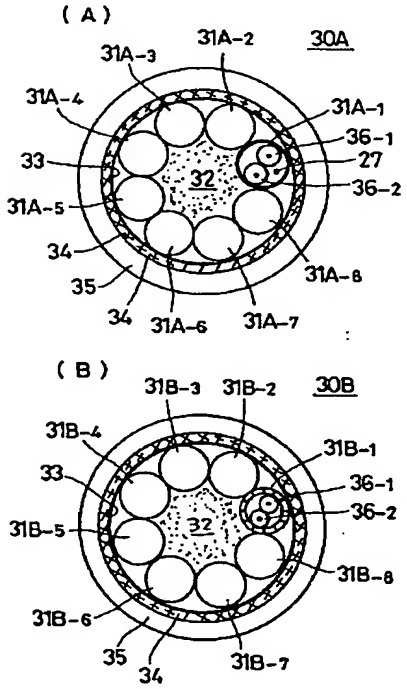
【図8】

図1の平衡伝送用コネクタの構造を示す図



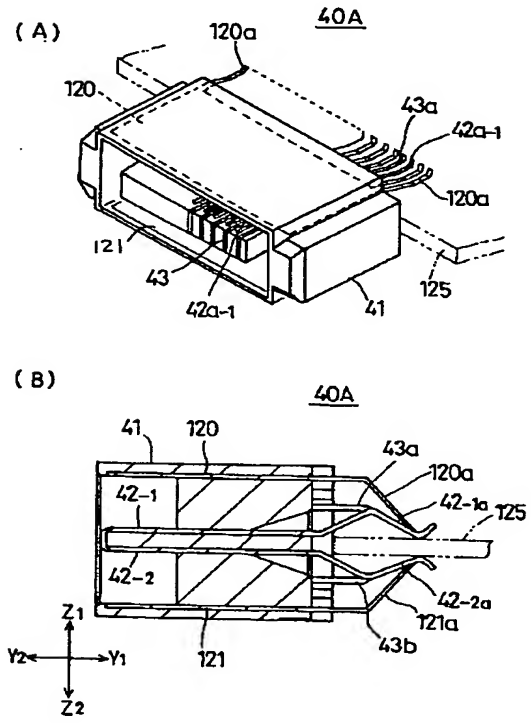
【図9】

平衡伝送用ケーブルの変形例を示す図



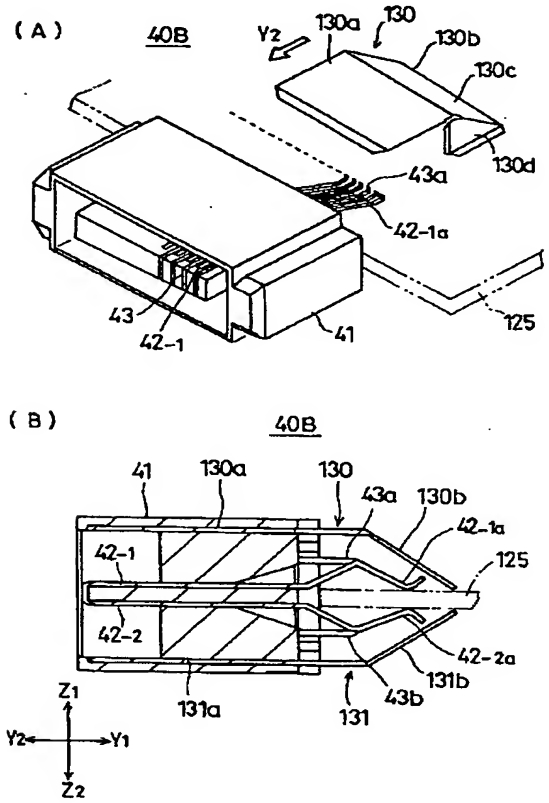
【図10】

平衡伝送用プラグの第1の変形例を示す図



【図11】

平衡伝送用プラグの第2の変形例を示す図



フロントページの続き

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BALANCED-TRANSMISSION CABLE-AND-CONNECTOR UNIT

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Applicant(s)::
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Equivalents:

Abstract

A balanced-transmission cable-and-connector unit includes a junction substrate, a plug for balanced transmission connected to one end of the junction substrate, a cable for balanced transmission connected to the other end of the junction substrate, and a shielding cover covering the junction substrate, a portion of the plug at which the plug is connected to the junction substrate and a portion of the cable at which the cable is connected to the junction substrate. The plug includes a pair of first and second signal contacts, and the length of a first signal transmitting path from the first signal contact to the cable via the junction substrate is substantially equal to the length of a second signal transmitting path from the second signal contact to the cable via the junction substrate

Description

BACKGROUND OF THE INVENTION

[0001] Field of the Invention

[0002] The present invention relates to a unit of connectors and a cable in which the connectors are connected with both ends of the cable, respectively, the unit having an arrangement such as to be used for balanced transmission. Hereinafter, such a unit will be referred to as a balanced-transmission cable-and-connector unit. In particular, the present invention relates to a balanced-transmission cable-and-connector unit used for connecting a computer with a peripheral device.

[0003] With the recent development of personal computers and networks thereof, systems are required for transmitting a large amount of data of, especially, dynamic images. In order to transmit a large amount of dynamic image data, it is necessary to transmit data at a high data transmission rate, not less than 1 gigabit/sec.

[0004] In the related art, unbalanced transmission is widely used in view of cost merit and so forth. However, because unbalanced transmission is likely to be affected by noise, it is considered that balanced transmission, which is less affected by noise, will be used in high-speed data transmission.

[0005] For connecting a personal computer with a peripheral device, a cable-and-connector unit, in which unit the connectors are connected with both ends of the cable, is used. It is therefore necessary to develop a cable-and-connector unit suitable for balanced transmission.

[0006] However, the cable-and-connector unit in the related art for connecting a personal computer with a peripheral device has a structure suitable for unbalanced transmission.

[0007] Thus, the cable-and-connector unit in the related art is not suitable for balanced transmission.

SUMMARY OF THE INVENTION

[0008] An object of the present invention is to provide a balanced-transmission cable-and-connector unit in which the problem described above is eliminated.

[0009] The above-mentioned object of the present invention is achieved by a balanced-transmission cable-and-connector unit which comprises:

]010] a junction substrate;

]11] a plug for balanced transmission connected to one end of the junction substrate;

12] a cable for balanced transmission connected to the other end of the junction substrate; and

3] a shielding cover covering the junction substrate, a portion of the plug at which the plug is

connected to the junction substrate and a portion of the cable at which the cable is connected to the junction substrate,
[0014] wherein:
[0015] the plug includes a pair of first and second signal contacts; and
[0016] the length of a first signal transmitting path from the first signal contact to the cable via the junction substrate is substantially equal to the length of a second signal transmitting path from the second signal contact to the cable via the junction substrate.
[0017] As a result of the length of the first signal transmitting path from the first signal contact to the cable via the junction substrate being substantially equal to the length of the second signal transmitting path from the second signal contact to the cable via the junction substrate, a time difference (skew) between a '+' signal and a '-' signal, which are transmitted in a manner of balanced transmission, does not occur, the magnitude of the '-' signal being equal to the magnitude of the '+' signal but the direction of the '-' signal being reverse to the direction of the '+' signal. As a result, the balanced-transmission cable-and-connector unit can be used for transmitting a high-speed signal of more than 1 gigabit/sec. with high reliability.
[0018] A balanced-transmission cable-and-connector unit, according to another aspect of the present invention, comprises:
[0019] a junction substrate;
[0020] a plug for balanced transmission connected to one end of the junction substrate;
[0021] a cable for balanced transmission connected to the other end of the junction substrate; and
[0022] a shielding cover covering the junction substrate, a portion of the plug at which the plug is connected to the junction substrate and a portion of the cable at which the cable is connected to the junction substrate,
[0023] wherein:
[0024] the plug includes a pair of first and second signal contacts;
[0025] the cable includes a plurality of sub-cables, the plurality of sub-cables being exposed from the end of the cable and connected to the end of the junction substrate; and
[0026] the length of a first signal transmitting path from the first signal contact to the cable via the junction substrate and an exposed sub-cable of the plurality of sub-cables is substantially equal to the length of a second signal transmitting path from the second signal contact to the cable via the junction substrate and another exposed sub-cable of the plurality of sub-cables.
[0027] As a result of the length of the first signal transmitting path from the first signal contact to the cable via the junction substrate and the exposed sub-cable of the plurality of sub-cables being substantially equal to the length of the second signal transmitting path from the second signal contact to the cable via the junction substrate and the other exposed sub-cable of the plurality of sub-cables, a time difference (skew) between the '+' signal and the signal, which are transmitted in the manner of balanced transmission, does not occur. As a result, the balanced-transmission cable-and-connector unit can be used for transmitting a high-speed signal of more than 1 gigabit/sec. with high reliability.
[0028] A balanced-transmission cable-and-connector unit, according to another aspect of the present invention, comprises:
[0029] a junction substrate;
[0030] a plug for balanced transmission connected to one end of the junction substrate;
[0031] a cable for balanced transmission connected to the other end of the junction substrate; and
[0032] a shielding cover covering the junction substrate, a portion of the plug at which the plug is connected to the junction substrate and a portion of the cable at which the cable is connected to the junction substrate,
[0033] wherein:
[0034] the plug comprises a housing made of synthetic resin and alternately arranged ground contacts and pairs of signal contacts, each pair of the pairs of signal contacts having first and second leg portions between which the end of the junction substrate is inserted, the lengths of the first and second leg portions of each pair of the pairs of signal contacts being equal to one another;
[0035] the cable comprises a tube-shaped outer covering portion, a tube-shaped sub-cable shielding portion provided inside the outer covering portion, a plurality of sub-cables circularly arranged along the inner surface of the sub-cable shielding portion and a filler portion filling a portion of the cable inside the plurality of sub-cables, each of the plurality of sub-cables comprising a pair of leads for balanced transmission and a lead shielding portion shielding the pair of leads;
[0036] the junction substrate has a multi-layer structure and has ground lands on the obverse surface and the reverse surface at one end thereof, the lead shielding portions being soldered to the ground lands, the junction substrate further having pairs of signal pads on the obverse surface and the reverse surface at the other end thereof, each pair comprising one pad on the obverse surface and the other on the reverse surface, the junction substrate further having pairs of lead connection pads on the obverse surface and the reverse surface thereof between the ground lands and the pairs of signal pads, each pair of the pairs of signal pads having the leads of the respective one of the plurality of sub-cables soldered thereto, the junction substrate further having first wiring connecting one pad of each pair of the pairs of lead connection pads with the obverse-surface-side pad of the respective pair of the pairs of

signal pads using an internal layer of the junction substrate and second wiring connecting the other pad of each pair of the pairs of lead connection pads with the reverse-surface-side pad of the respective pair of the pairs of signal pads using another internal layer of the junction substrate, the length of the first wiring being substantially equal to the length of the second wiring;
[0037] the first and second leg portions of each pair of the pairs of signal contacts of the plug has the junction substrate inserted therebetween, and two leg portions of each of the ground contacts of the plug has the junction substrate inserted therebetween, the first leg portion of each pair of the pairs of signal contacts being soldered to the obverse-surface-side pad of the respective pair of the pairs of signal pads and the second leg portion of each pair of the pairs of signal contacts being soldered to the reverse-surface-side pad of the respective pair of the pairs of signal pads, thus the plug being connected with the end of the junction substrate;
[0038] the plurality of sub-cables exposed from the end of the cable are equally separated into sub-cables on the obverse-surface side of the junction substrate and sub-cables on the reverse-surface side of the junction substrate, the pair of leads of each of the plurality of sub-cables being soldered to the respective pair of the pairs of lead connection pads, respectively; and
[0039] the shielding cover has shielding-plate portions at one end thereof and shielding-arm portions at the other end thereof, the shielding-plate portions being inserted into the plug and the shielding-arm portions being connected with the sub-cable shielding portion of the cable, thus the shielding cover being fastened to the plug and the cable.
[0040] Because the junction substrate has the multi-layer structure, and the first wiring and the second wiring use the internal layers, it is possible that the length of the first wiring is approximately equal to the length of the second wiring. Further, the sub-cables of the cable are arranged circularly, and also, the sub-cables exposed from the end of cable are equally separated into the sub-cables on the obverse-surface side of the junction substrate and the reverse-surface side of the junction substrate. As a result, it is possible that the lengths of the sub-cables exposed from the end of the cable are approximately equal to each other. Thereby, a time difference (skew) between the '+' signal and the '-' signal, which are transmitted in the manner of balanced transmission, does not occur. Further, a time difference (skew) between the signals transmitted through the plurality of sub-cables does not occur. As a result, the balanced-transmission cable-and-connector unit can be used for transmitting a high-speed signal of more than 1 gigabit/sec. with high reliability.
[0041] Further, the shielding-plate portions are portions of the shielding cover and are not separate parts. Therefore, it is not necessary to increase the number of parts.
[0042] A plug for balanced transmission, according to the present invention, comprises:
[0043] a housing made of synthetic resin;
[0044] alternately arranged ground contacts and pairs of signal contacts; and
[0045] two shielding plates incorporated into the housing oppositely,
[0046] wherein:
[0047] each pair of the pairs of signal contacts has first and second leg portions between which an end of a printed-circuit board is inserted, the lengths of the first and second leg portions of each pair of the pairs of signal contacts being equal to one another;
[0048] each of the ground contacts has leg portions between which the end of the printed-circuit board is inserted; and
[0049] the two shielding plates have leg portions between which the end of the printed-circuit board is inserted.
[0050] Because each pair of the pairs of signal contacts has first and second leg portions between which the end of the printed-circuit board is inserted, it is possible that the plug for balanced transmission is connected to the printed-circuit board in a manner in which the printed-circuit board is located on the center line of the plug. Thereby, a time difference (skew) between the '+' signal and the '-' signal, which are transmitted in the manner of balanced transmission, does not occur.
[0051] A plug for balanced transmission, according to another aspect of the present invention, comprises:
[0052] a housing made of synthetic resin;
[0053] alternately arranged ground contacts and pairs of signal contacts; and
[0054] two shielding members inserted into the housing oppositely,
[0055] wherein:
[0056] each pair of the pairs of signal contacts has first and second leg portions between which an end of a printed-circuit board is inserted, the lengths of the first and second leg portions of each pair of the pairs of signal contacts being equal to one another;
[0057] each of the ground contacts has leg portions between which the end of the printed-circuit board is inserted; and
[0058] the two shielding members have shielding-plate portions which are inserted into the housing, and covering portions which cover the first and second leg portions of each pair of the pairs of signal contacts and the leg portions of each of the ground contacts when the shielding-plate portions are inserted into the housing.
[0059] Because each pair of the pairs of signal contacts has first and second leg portions between

which the end of the printed-circuit board is inserted, it is possible that the plug for balanced transmission is connected to the printed-circuit board in a manner in which the printed-circuit board is located on the center line of the plug. Thereby, a time difference (skew) between the '+' signal and the '-' signal, which are transmitted in the manner of balanced transmission, does not occur.
[0060] Further, because the first and second leg portions of each pair of the pairs of signal contacts and the leg portions of each of the ground contacts are covered by the covering portions of the shielding members, the first and second leg portions of each pair of the pairs of signal contacts and the leg portions of each of the ground contacts are not likely to be affected by external electromagnetic noise.
[0061] Other objects and further features of the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0062] FIG. 1 shows a balanced-transmission cable-and-connector unit in one embodiment of the present invention;
[0063] FIG. 2 shows an exploded perspective view of a portion of the balanced-transmission cable-and-connector unit shown in FIG. 1;
[0064] FIG. 3 shows a sectional view taken along the line 3-3 shown in FIG. 1;
[0065] FIG. 4 shows a sub-assembly including a plug, a junction substrate and an end portion of a cable;
[0066] FIG. 5 shows the plug for balanced transmission of the balanced-transmission cable-and-connector unit shown in FIG. 1 and a corresponding jack for balanced transmission;
[0067] FIG. 6 shows a cross-sectional view of the cable for balanced transmission;
[0068] FIGS. 7A, 7B and 7C show a structure of the junction substrate;
[0069] FIG. 8 shows a structure of a connector for balanced transmission of the balanced-transmission cable-and-connector unit shown in FIG. 1;
[0070] FIGS. 9A and 9B show variant embodiments of the cable for balanced transmission;
[0071] FIGS. 10A and 10B show a variant embodiment of the plug for balanced transmission; and
[0072] FIGS. 11A and 11B show another variant embodiment of the plug for balanced transmission.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0073] FIG. 1 shows a balanced-transmission cable-and-connector unit 10 in one embodiment of the present invention. The balanced-transmission cable-and-connector unit 10 has an arrangement in which connectors 11, 12 for balanced transmission are connected with both ends of a cable 30 for balanced transmission. The connector 11 of one end is connected with a jack 20, for balanced transmission, of a personal computer. The connector 12 of the other end is connected with a jack, for balanced transmission, of a peripheral device. Thus, the balanced-transmission cable-and-connector unit 10 connects the personal computer with the peripheral device.
[0074] As shown in FIG. 2 in an exploded manner, an end portion of the balanced-transmission cable-and-connector unit 10 includes an end portion of the cable 30 for balanced transmission, a plug 40 for balanced transmission, a junction substrate 50, a shielding cover 80 and a caulking ring 95. In a sub-assembly 100, shown in FIG. 4, the plug 40 is connected to the Y2-direction end of the junction substrate 50, and the cable 30 is soldered to the Y1-direction end of the junction substrate 50.
[0075] In the jack 20 for balanced transmission, as shown in FIG. 5, pairs of jack-side signal contacts 22-1, 22-2 and ground contacts 23 are alternately arranged in the X1, X2 directions and put in a housing 21 made of synthetic resin and having a box-shape. Further, rectangular shielding plates 24, 25 each extending in the X1, X2 directions and Y1, Y2 directions are put in both sides of the housing 21. This jack 20 for balanced transmission is mounted on a printed-circuit board 26 inside the personal computer. The signal contacts 22-1, 22-2 are electrically connected with signal patterns of the printed-circuit board 26. The ground contacts 23 and the shielding plates 24, 25 are electrically connected with the ground of the printed-circuit board 26. Each ground contact 23 has a size such that each ground contact 23 covers the X-direction projected area of each pair of signal contacts 22-1, 22-2. As shown in FIG. 1, recess portions 27 are formed on X1, X2-direction end surfaces, in which recess portions 27 predetermined portions of the connector 11 are fitted.
[0076] As shown in FIG. 5, in the plug 40 for balanced transmission, pairs of first and second signal contacts 42-1, 42-2 and ground contacts 43 are alternately arranged at pitches corresponding to those in the jack 20 for balanced transmission and put in a housing 41 made of synthetic resin and having a box-shape. Each ground contact 43 has a size such that each ground contact 43 covers the X-direction projected area of each pair of signal contacts 42-1, 42-2.
[0077] Each pair of signal contacts 42-1, 42-2 has leg portions 42-1a, 42-2a each projecting outside the housing 41. Each of the leg portions 42-1a, 42-2a has a V-shape, the leg portions 42-1a, 42-2a are symmetrical with respect to the center line 44 of the plug 40 for balanced transmission, and can hold the junction substrate 50 therebetween. The length of the leg portion 42-1a is equal to the length of the leg portion 42-2a. The length between the end A1 of the first signal contact 42-1 and the extending end

B1 of the leg portion 42-1a along the first signal contact 42-1 is equal to the length between the end A2 of the second signal contact 42-2 and the extending end B2 of the leg portion 42-2a along the second signal contact 42-2.

[0078] Each ground contact 43 has two leg portions 43a, 43b. The leg portions 43a, 43b extend so that the distance therebetween is smaller at the position thereof nearer to the Y1-direction ends thereof, and can hold the junction substrate 50 therebetween.

[0079] Further, as shown in FIG. 4, the housing 41 has arms 45 projecting from the four corners thereof in the Y1 direction. Each arm 45 has a movement-preventing claw 45a as shown in FIG. 5.

[0080] As shown in FIG. 6, in the cable 30 for balanced transmission, on a cross section perpendicular to the axis line, 8 sub-cables 31-1 through 31-8 are arranged so as to form a circle. In the cable 30, the 8 sub-cables 31-1 through 31-8 surround a central electrically insulating filler portion 32, are held by a holding winding portion (wrapping tape) 33, then, are covered by a sub-cable-group shielding mesh 34 for shielding the group of sub-cables, and, then, are covered by a tube-shaped electrically insulating outer covering portion 35. Because the 8 sub-cables 31-1 through 31-8 are arranged circularly, it is possible that the lengths of the sub-cables are equal to each other, when the sub-cables are exposed from the end of cable 30 and connection thereof is made separately.

[0081] Each of the sub-cables 33-1 through 33-8 includes a pair of first and second covered leads 36-1, 36-2 for balanced transmission, a lead shielding mesh 37 for covering the pair of first and second covered leads 36-1, 36-2, and a holding winding portion (wrapping tape) 38 which covers the lead shielding mesh 37. Each of the first and second covered leads 36-1, 36-2 includes the respective one of first and second leads 39-1, 39-2, and a covering portion 29.

[0082] As shown in FIGS. 7A, 7B and 7C, the junction substrate 50 has a rectangular-shape which is long in the Y1, Y2 directions, and has a 4-layer structure including an obverse surface layer 51, a reverse surface layer 52, a first internal layer 53 and a second internal layer 54.

[0083] As shown in FIGS. 7B and 7C, ground lands 55, 56 to which the lead shielding meshes 37 are soldered are formed on the obverse surface layer 51 and on the reverse surface layer 52, at the Y1-direction end respectively.

[0084] At the Y2-direction end on the obverse surface layer 51, signal pads and ground pads are arranged alternately in order of the signal pad 57-1, the ground pad 58-1, the signal pad 57-2, the ground pad 58-2, . . . , in the X2 direction. Identically, at the Y2-direction end on the reverse surface layer 52, signal pads and ground pads are arranged alternately in order of the signal pad 59-1, the ground pad 60-1, the signal pad 59-2, the ground pad 60-2, . . . , in the X2 direction. The signal pads 57-1 and 59-1 are used as a pair, the signal pads 57-2 and 59-2 are used as a pair, ... Thus, there are 8 pairs of signal pads. The ground pads 58-1, 58-2, . . . are connected with the ground land 55. The ground pads 60-1, 60-2, . . . are connected with the ground land 56.

[0085] At approximately middle in the Y1, Y2 direction on the obverse surface layer 51 of the junction substrate 50, lead connection pads 61-1, 61-2, . . . , 61-8 are formed side by side in the X1, X2 directions. The adjacent lead connection pads 61-1, 61-2 form a first pair, the subsequent adjacent lead connection pads 61-3, 61-4 form a second pair, ... Identically, at approximately middle in the Y1, Y2 direction on the reverse surface layer 52 of the junction substrate 50, lead connection pads 62-1, 62-2, . . . , 62-8 are formed side by side in the X1, X2 directions. The adjacent lead connection pads 62-1, 62-2 are used as a pair, the subsequent adjacent lead connection pads 62-3, 62-4 are used as a pair,.

[0086] The pairs of lead connection pads are connected with the pairs of signal pads through wirings, respectively. Connection between the pair of lead connection pads 61-1, 61-2 and the pair of signal pads 57-1, 59-1 will now be described, for example.

[0087] The lead connection pad 61-2 and the signal pad 57-1 are connected by a first wiring 63. The first wiring 63 includes a via hole 64 extending from the lead connection pad 61-2 to the first internal layer 53, a wiring pattern 65 extending on the first internal layer 53 from the bottom end of the via hole 64, a via hole 66 extending from the wiring pattern 65 on the first internal layer 53 to the obverse surface layer 51, and a wiring pattern 67 extending from the top end of the via hole 66 to the signal pad 57-1.

[0088] The lead connection pad 61-1 and the signal pad 59-1 are connected by a second wiring 68. The second wiring 68 includes a via hole 69 extending from the lead connection pad 61-1 to the second internal layer 54, a wiring pattern 70 extending on the second internal layer 54 from the bottom end of the via hole 69, a via hole 71 extending from the wiring pattern 70 on the second internal layer 54 to the reverse surface layer 52, and a wiring pattern 72 extending from the bottom end of the via hole 71 to the signal pad 59-1.

[0089] The distance 't' between the first and second internal layers 53 and 54 is small, that is, 0.1 through 0.2 mm. Accordingly, the length of the first wiring 63 is approximately equal to the length of the second wiring 68. That is, the length between the position C1 of the signal pad 57-1 and the position D1 of the lead connection pad 61-2 along the first wiring 63 is approximately equal to the length between the position C2 of the signal pad 59-1 and the position D2 of the lead connection pad 61-1 along the second wiring 68.

[0090] The other pairs of lead connection pads on the obverse surface layer 51 and the other pairs of lead connection pads on the reverse surface layer 52 are connected with the other pairs of signal pads,

in manners each identical to the above-described manner, respectively.
[0091] The shielding cover 80 is made from a metal plate through press working and has a shape of a hollow, approximately square pole. The shielding cover 80 includes a body 81 having the shape of the hollow, approximately square pole shape, shielding-plate portions 82, 83 extending in the Y2 direction from the Z1, Z2-direction-end edges of the Y2-direction end of the body 81, locking-arm portions 84, 85 extending in the Y2 direction from the X1, X2-direction-end edges of the Y2-direction end of the body 81, shown in FIG. 2, shielding-arm portions 86, 87 extending in the Y1 direction from the Z1, Z2-direction-end edges of the Y1-direction end of the body 81, shown in FIGS. 2 and 3, and engaging openings 88 formed near the Y2-direction end of the body 81, shown in FIG. 2.
[0092] The sub-assembly 100 will now be described.
[0093] As shown in FIG. 4, as described above, in the sub-assembly 100, the plug 40 for balanced transmission is connected to the Y2-direction end of the junction substrate 50, and the cable 30 for balanced transmission is connected with the Y1direction end of the junction substrate 50.
[0094] As shown in FIG. 3, the V-shaped leg portions 42-1a, 42-2a of the first and second signal contacts 42-1, 42-2 and the two leg portions 43a, 43b of the ground contacts 43 of the plug 40 for balanced transmission elastically hold the junction substrate 50 therebetween. In this condition, the leg portion 42-1a of the X1-direction-end first signal contact 42-1 is soldered to the signal pad 57-1, the leg portion 42-2a of the X1-direction-end second signal contact 42-2 is soldered to the signal pad 59-1, the leg portion 43a of the adjacent ground contact 43 is soldered to the ground pad 58-1, and the leg portion 43b the same ground contact 43 is soldered to the ground pad 60-1. Similarly, the other leg portions are soldered to the other signal pads and the other ground pads, respectively.
[0095] The junction substrate 50 is located on the center line 44 of the plug 40 for balanced transmission.
[0096] The end of the cable 30 for balanced transmission is processed as shown in FIG. 2. An end portion of the sub-cable-group shielding mesh 34 is exposed, and end portions of the 8 sub-cables 31-1 through 31-8 are exposed. For each of the sub-cables 31-1 through 31-8, an end portion of the lead shielding mesh 37 is exposed, end portions of the first and second covered leads 36-1, 36-2 are exposed, and end portions of the first and second leads 39-1, 39-2 are exposed as a result of end portions of the covering portions 29 of the first and second covered leads 36-1, 36-2 being stripped.
[0097] The exposed 8 sub-cables 31-1 through 31-8 are separated, by the horizontal plane 28 (shown in FIG. 2) including the center line of the cable 30, into the upper-half 4 sub-cables 31-1 through 31-4 and the lower-half 4 sub-cables 31-5 through 31-8. The 4 sub-cables 31-1 through 31-4 are aligned and extend to the side of the obverse surface layer 51 of the junction substrate 50, and the 4 sub-cables 31-5 through 31-8 are aligned and extend to the side of the reverse surface layer 52 of the junction substrate 50.
[0098] The 4 sub-cables 31-1 through 31-4 are arranged in the X1, X2 directions, and the respective lead shielding meshes 37 are soldered to the ground land 55 of the junction substrate 50. Thus, the sub-cables 31-1 through 31-4 are connected to the junction substrate 50. The first and second covered leads 36-1, 36-2 of the sub-cable 31-1 extend in the Y2 direction along the obverse surface layer 51. The first lead 39-1 is soldered to the lead connection pad 61-2, and the second lead 39-2 is soldered to the lead connection pad 61-1. For the other sub-cables 31-2 through 31-4, the covered leads are aligned, and the exposed leads are soldered to the respective lead connection pads, in manners each identical to the above-described manner applied to the sub-cable 31-1. Identically, for the 4 sub-cables 31-5 through 31-8 on the reverse surface side, the respective lead shielding meshes 37 are soldered to the ground land 56 of the junction substrate 50, thus, the sub-cables 31-5 through 31-8 are connected to the junction substrate 50, the covered leads are aligned, and the exposed leads are soldered to the lead connection pads 62-2, 62-1, Because the first and second covered leads 36-1, 36-2 extend symmetrically, the length between the position EI of the exposed lead 39-1 and the position FI of the lead shielding mesh 37 is equal to the length between the position E2 of the exposed lead 39-2 and the position F2 of the lead shielding mesh 37.
[0099] As mentioned above, the 8 sub-cables 31-1 through 31-8 are arranged so as to form the circle in the cable 30, and the 8 sub-cables 31-1 through 31-8 are separated by the horizontal plane 28 into the upper-half 4 sub-cables and the lower-half 4 sub-cables. Thereby, the lengths of the respective sub-cables 31-1 through 31-8 exposed from the end of the sub-cable-group shielding mesh 34 are approximately equal to each other. That is, the lengths between the positions G at the end of the exposed sub-cable-group shielding mesh 34 and the positions of the exposed lead shielding meshes 37 of the respective sub-cables are approximately equal to each other. Accordingly, the lengths of the first and second leads of all the sub-cables 31-1 through 31-8 are approximately equal to each other.
[0100] In the above-described sub-assembly 100, paths through which a '+' signal and a '-' signal are transmitted will now be described.
[0101] With reference to FIG. 3, the length of the path between the position AI and the position G through which the '+' signal is transmitted, that is, the length of the path passing through the first signal contact 42-1, the first wiring 63, the exposed first covered lead 36-1 and the exposed sub-cable 31-1, and the length of the path between the position A2 and the position G through which the '-' signal is transmitted, that is, the length of the path passing through the second signal contact 42-2, the second

wiring 68, the exposed second covered lead 36-2 and the exposed sub-cable 31-1, are approximately equal to one another. The difference therebetween corresponds to a signal transmission time difference which is equal to or less than a permissible error 100 ps/m.
[0102] Further, the lengths of the paths passing through the first and second signal contacts, the first and second wiring, the exposed first and second covered leads and the exposed sub-cables are approximately equal between the 8 sub-cables 31-1 through 31-8. The maximum difference therebetween corresponds to a signal transmission time difference which is equal to or less than a permissible error 150 ps/m.
[0103] When such a plug for balanced transmission is connected to an end of such a junction substrate, a general manner is such that a so-called right-angle-type plug for balanced transmission is mounted on the junction substrate. However, when the right-angle-type plug is used, a significant difference occurs in length between the first and second signal contacts. Therefore, the right-angle-type plug is not suitable for balanced transmission, and the above-described embodiment does not use the right-angle-type plug.
[0104] When the shielding cover 80 and the caulking ring 95 are integrated to the sub-assembly 100, the connector 11 for balanced transmission is completed.
[0105] As shown in FIG. 3, the shielding cover 80 is coupled with the plug 40 for balanced transmission as a result of the Y2-direction end of the body 81 being fitted by the four-corner arm 45 of the plug 40, and the engaging openings 88 engaging with the movement-preventing claws 45a. The body 81 surrounds and covers the sub-assembly 100, and covers the junction substrate 50, a portion of the plug 40 for balanced transmission at which the plug 40 is connected with the junction substrate 50, and a portion of the cable 30 for balanced transmission at which the cable 30 is connected with the junction substrate 50.
[0106] The shielding-plate portions 82, 83 are inserted into the box-shaped housing 41 of the plug 40, and are located on the inner walls, of the housing 41, which walls face one another in the Z1, Z2 directions. The locking arms 84, 85 also are inserted into the housing 41, and are located on the inner walls of the housing 41, which walls face one another in the X1, X2 directions.
[0107] At the X1, X2-direction ends the caulking ring 95 are caulked (so that the caulking ring 95 comes to have the shape shown in FIG. 1), and, thereby, the shielding-arm portions 86, 87 are fastened to sub-cable-group shielding mesh 34 in a manner of crimping using the caulking ring 95. Thus, the Y1direction end of the body 81 is fixed to the end of the cable 30.
[0108] The connector 11 for balanced transmission is connected with the jack 20 for balanced transmission as a result of the locking arms 84, 85 being fitted into the recess portions 27. The balanced-transmission cable-and-connector unit 10 provides 8 balanced transmission paths between the personal computer and the peripheral device.
[0109] The connector 11 for balanced transmission and the balanced-transmission cable-and-connector unit 10 have the following features and advantages:
[0110] The length of the path between the position A1 and the position G through which the '+' signal is transmitted is substantially equal to the length of the path between the position A2 and the position G through which the '-' signal is transmitted, the magnitude of the '-' signal being equal to the magnitude of the '+' signal but the direction of the '-' signal being reverse to the direction of the '+' signal. Thereby, a time difference (skew) between the '+' signal and the '-' signal, which are transmitted in a manner of balanced transmission, does not occur. As a result, the balanced-transmission cable-and-connector unit 10 can be used for transmitting a high-speed signal of more than 1 gigabit/sec. with high reliability.
[0111] The lengths of the 8 balanced-transmission paths are substantially equal to each other. Thereby, a time difference (skew) between the 8 sorts of signals, which are transmitted through the 8 balanced transmission paths in a manner of balanced transmission, does not occur. As a result, the balanced-transmission cable-and-connector unit 10 provides 8-channel transmission paths which can be used for transmitting 8 sorts of high-speed signals of more than 1 gigabit/sec. with high reliability.
[0112] As shown in FIG. 8, in the connector 11 for balanced transmission, the ground contact 43 is inserted between each adjacent first signal contacts 42-1, 42-1 arranged side by side in the X1, X2 directions, and between each adjacent second signal contacts 42-2, 42-2 arranged side by side in the X1, X2 directions. Thus, a stripline structure is formed. Thereby, in the connector 11 for balanced transmission, occurrence of crosstalk between signals, which are transmitted through each adjacent signal contacts and each adjacent signal pads, arranged side by side in the X1, X2 directions, can be effectively restricted.
[0113] As shown in FIG. 8, an imaginary ground plane 110 is formed between each first and second signal contacts 42-1, 42-2 which are used as a pair for balanced transmission. As a result of the imaginary ground plane 110 being formed, occurrence of crosstalk between the '+' signal transmitted through the first signal contact 42-1 and the '-' signal transmitted through the second signal contact 42-2 can be effectively restricted.
[0114] The shielding-plate portions 82, 83 which are inserted into the housing 41 shield the first and second signal contacts 42-1, 42-2 from an external electromagnetic wave. Thereby, it is restricted that the '+' signals and the '-' signals transmitted through the first and second signal contacts 42-1, 42-2 in the manner of balanced transmission are affected by an electromagnetic wave outside the connector

11.
[0115] The shielding-plate portions 82, 83 are portions of the shielding cover 80 and are not separate parts. Therefore, it is not necessary to increase the number of parts.
[0116] The connector 12 for balanced transmission connected with the other end of the cable 30 for balanced transmission, shown in FIG. 1, has the same structure as the structure of the connector 11 for balanced transmission.
[0117] FIGS. 9A and 9B show variant embodiments of the cable 30 for balanced transmission. The same reference numerals are given to the same portions as those shown in FIG. 6, and description thereof will be omitted.
[0118] In a cable 30A for balanced transmission, shown in FIG. 9A, in each of sub-cables 33A-1 through 33A-8, a drain wire 27 is included in addition to the first and second covered leads 36-1, 36-2 which are used as a pair for balanced transmission. The drain wire 27 is in contact with the lead shielding mesh 37 in each sub-cable.
[0119] In a cable 30B for balanced transmission, shown in FIG. 9B, the holding winding portion 38 is omitted from each of the sub-cables 33B-1 through 33B-8.
[0120] FIGS. 10A, 10B and FIGS. 11A, 11B show variant embodiments of the plug 40 for balanced transmission shown in FIGS. 2 and 5. In each figure, the same reference numerals are given to portions corresponding to those shown in FIGS. 2 and 5, and description thereof will be omitted.
[0121] In a plug 40A for balanced transmission shown in FIGS. 10A and 10B, shielding plates 120, 121 are incorporated into the housing 41 on the top side and on the bottom side, respectively. The shielding plates 120 has legs 120a which project from both sides of the Y1-direction-end edge of the shielding plate 120 in the Y1 direction. The shielding plates 121 has legs 121a which project from both sides of the Y1-direction-end edge of the shielding plate 121 in the Y1 direction. The legs 120a of the top-side shielding plate 120 and the legs 121a of the bottom-side shielding plate 121 extend so that the distances between the legs 120a and legs 121a are shorter at the positions nearer to the projecting ends thereof.
[0122] The V-shaped leg portions 42-1a, 42-2a of each pair of first and second signal contacts 42-1, 42-2, the two leg portions 43a, 43b of each ground contact 43, and the legs 120a of the top-side shielding plate 120 and the legs 121a of the bottom-side shielding plate 121 elastically hold the printed-circuit board 125 therebetween. In this condition, the leg portions 42-1a, 42-2a of each pair of first and second signal contacts 42-1, 42-2, the two leg portions 43a, 43b of each ground contact 43, and the legs 120a of the topside shielding plate 120 and the legs 121a of the bottom-side shielding plate 121 are soldered to corresponding pads of the printed-circuit board 125. Thus, the plug 40A for balanced transmission is connected with an end portion of the printed-circuit board 125.
[0123] In a plug 40B for balanced transmission shown in FIGS. 11A and 11B, shielding members 130, 131 are incorporated in the housing 41 instead of the above-described shielding plates 120, 121. The shielding members 130, 131 include shielding-plate portions 130a, 131a, and covering portions 130b, 131b, respectively. The covering portion 130b includes a hood portion 130c and side-plate portions 130d at both sides of the hood portion 130c. The covering portion 131b has the same structure. After the plug 40B for balanced transmission is connected with an end portion of a printed-circuit board 125, the shielding members 130, 131 are fasten to the plug 40B as a result of the shielding-plate portions 130a, 131a being press-fitted in the Y2 direction into the housing 41. As a result, the covering portions 130b, 131b covers the V-shaped leg portions 42-1a, 42-2a of each pair of first and second signal contacts 42-1, 42-2, and the two leg portions 43a, 43b of each ground contact 43. Thereby, the signals transmitted through the signal contacts are not likely to be affected by external electromagnetic noise.
[0124] Further, the present invention is not limited to the above-described embodiments, and variations and modifications may be made without departing from the scope of the present invention.
[0125] The contents of the basic Japanese Patent Application No.10-234708, filed on Aug. 20, 1998, are hereby incorporated by reference.

Claims

What is claimed is:

1. A balanced-transmission cable-and-connector unit comprising:
a junction substrate;
a plug for balanced transmission connected to one end of said junction substrate;
a cable for balanced transmission connected to the other end of said junction substrate; and
a shielding cover covering said junction substrate, a portion of said plug at which said plug is connected to said junction substrate and a portion of said cable at which said cable is connected to said junction substrate,
wherein:
said plug includes a pair of first and second signal contacts; and

the length of a first signal transmitting path from said first signal contact to said cable via said junction substrate is substantially equal to the length of a second signal transmitting path from said second signal contact to said cable via said junction substrate.

2. A balanced-transmission cable-and-connector unit comprising:
a junction substrate;
a plug for balanced transmission connected to one end of said junction substrate;
a cable for balanced transmission connected to the other end of said junction substrate; and
a shielding cover covering said junction substrate, a portion of said plug at which said plug is connected to said junction substrate and a portion of said cable at which said cable is connected to said junction substrate,
wherein:
said plug includes a pair of first and second signal contacts;
said cable includes a plurality of sub-cables, said plurality of sub-cables being exposed from the end of said cable and connected to said end of said junction substrate; and
the length of a first signal transmitting path from said first signal contact to said cable via said junction substrate and an exposed sub-cable of said plurality of sub-cables is substantially equal to the length of a second signal transmitting path from said second signal contact to said cable via said junction substrate and another exposed sub-cable of said plurality of sub-cables.

3. A balanced-transmission cable-and-connector unit comprising:
a junction substrate;
a plug for balanced transmission connected to one end of said junction substrate;
a cable for balanced transmission connected to the other end of said junction substrate; and
a shielding cover covering said junction substrate, a portion of said plug at which said plug is connected to said junction substrate and a portion of said cable at which said cable is connected to said junction substrate,
wherein:
said plug comprises a housing made of synthetic resin and alternately arranged ground contacts and pairs of signal contacts, each pair of said pairs of signal contacts having first and second leg portions between which said end of said junction substrate is inserted, the lengths of said first and second leg portions of each pair of said pairs of signal contacts being equal to one another;
said cable comprises a tube-shaped outer covering portion, a tube-shaped sub-cable shielding portion provided inside said outer covering portion, a plurality of sub-cables circularly arranged along the inner surface of said sub-cable shielding portion and a filler portion filling a portion of said cable inside said plurality of sub-cables, each of said plurality of sub-cables comprising a pair of leads for balanced transmission and a lead shielding portion shielding said pair of leads;
said junction substrate has a multi-layer structure and has ground lands on the obverse surface and the reverse surface at one end thereof, the lead shielding portions of said plurality of sub-cables being soldered to said ground lands, said junction substrate further having pairs of signal pads on said obverse surface and said reverse surface at the other end thereof, each pair of said pairs of signal pads comprising one pad on said obverse surface and the other pad on said reverse surface, said junction substrate further having pairs of lead connection pads on said obverse surface and said reverse surface thereof between said ground lands and said pairs of signal pads, each pair of said pairs of signal pads having the leads of the respective one of said plurality of sub-cables soldered thereto, said junction substrate further having a first wiring connecting one pad of each pair of said pairs of lead connection pads with the obverse-surface-side pad of the respective pair of said pairs of signal pads using an internal layer of said junction substrate and a second wiring connecting the other pad of each pair of said pairs of lead connection pads with the reverse-surface-side pad of the respective pair of said pairs of signal pads using another internal layer of said junction substrate, the length of said first wiring being substantially equal to the length of said second wiring;
the first and second leg portions of each pair of said pairs of signal contacts of said plug has said junction substrate inserted therebetween, and two leg portions of each of said ground contacts of said plug has said junction substrate inserted therebetween, said first leg portion of each pair of said pairs of signal contacts being soldered to the obverse-surface-side pad of the respective pair of said pairs of signal pads and said second leg portion of each pair of said pairs of signal contacts being soldered to the reverse-surface-side pad of the respective pair of said pairs of signal pads, thus said plug being connected with said end of said junction substrate;
said plurality of sub-cables exposed from the end of said cable are equally separated into sub-cables on the obverse-surface side of said junction substrate and sub-cables on the reverse-surface side of said junction substrate, the pair of leads of each of said plurality of sub-cables being soldered to the respective pair of said pairs of lead connection pads, respectively; and
said shielding cover has shielding-plate portions at one end thereof and shielding-arm portions at the other end thereof, said shielding-plate portions being inserted into said plug and said shielding-arm portions being connected with said sub-cable shielding portion of said cable, thus said shielding cover

being fastened to said plug and said cable.

4. A connector for balanced transmission comprising:
a plug for balanced transmission;
a junction substrate, to one end of which said plug is connected, and to the other end of which a cable for balanced transmission is connected; and
a shielding cover covering said junction substrate, a portion of said plug at which said plug is connected to said junction substrate and a portion of said cable at which said cable is connected to said junction substrate,
wherein:
said plug includes a pair of first and second signal contacts; and
the length of a first signal transmitting path from said first signal contact to said cable via said junction substrate is substantially equal to the length of a second signal transmitting path from said second signal contact to said cable via said junction substrate.

5. A connector for balanced transmission comprising:
a plug for balanced transmission;
a junction substrate, to one end of which said plug is connected, and to the other end of which a cable for balanced transmission is connected; and
a shielding cover covering said junction substrate, a portion of said plug at which said plug is connected to said junction substrate and a portion of said cable at which said cable is connected to said junction substrate,
wherein:
said plug includes a pair of first and second signal contacts;
said cable includes a plurality of sub-cables, said plurality of sub-cables being exposed from the end of said cable and connected to said end of said junction substrate; and
the length of a first signal transmitting path from said first signal contact to said cable via said junction substrate and an exposed sub-cable of said plurality of sub-cables is substantially equal to the length of a second signal transmitting path from said second signal contact to said cable via said junction substrate and another exposed sub-cable of said plurality of sub-cables.

6. A connector for balanced transmission comprising:
a plug for balanced transmission;
a junction substrate, to one end of which said plug is connected, and to the other end of which a cable for balanced transmission is connected; and
a shielding cover covering said junction substrate, a portion of said plug at which said plug is connected to said junction substrate and a portion of said cable at which said cable is connected to said junction substrate,
wherein:
said plug comprises a housing made of synthetic resin and alternately arranged ground contacts and pairs of signal contacts, each pair of said pairs of signal contacts having first and second leg portions between which said end of said junction substrate is inserted, the lengths of said first and second leg portions of each pair of said pairs of signal contacts being equal to one another;
said cable comprises a tube-shaped outer covering portion, a tube-shaped sub-cable shielding portion provided inside said outer covering portion, a plurality of sub-cables circularly arranged along the inner surface of said sub-cable shielding portion and a filler portion filling a portion of said cable inside said plurality of sub-cables, each of said plurality of sub-cables comprising a pair of leads for balanced transmission and a lead shielding portion shielding said pair of leads;
said junction substrate has a multi-layer structure and has ground lands on the obverse surface and the reverse surface at one end thereof, the lead shielding portions of said plurality of sub-cables being soldered to said ground lands, said junction substrate further having pairs of signal pads on said obverse surface and said reverse surface at the other end thereof, each pair of said pairs of signal pads comprising one pad on said obverse surface and the other pad on said reverse surface, said junction substrate further having pairs of lead connection pads on said obverse surface and said reverse surface thereof between said ground lands and said pairs of signal pads, each pair of said pairs of signal pads having the leads of the respective one of said plurality of sub-cables soldered thereto, said junction substrate further having a first wiring connecting one pad of each pair of said pairs of lead connection pads with the obverse-surface-side pad of the respective pair of said pairs of signal pads using an internal layer of said junction substrate and a second wiring connecting the other pad of each pair of said pairs of lead connection pads with the reverse-surface-side pad of the respective pair of said pairs of signal pads using another internal layer of said junction substrate, the length of said first wiring being substantially equal to the length of said second wiring;
the first and second leg portions of each pair of said pairs of signal contacts of said plug has said junction substrate inserted therebetween, and two leg portions of each of said ground contacts of said plug has said junction substrate inserted therebetween, said first leg portion of each pair of said pairs of

signal contacts being soldered to the obverse-surface-side pad of the respective pair of said pairs of signal pads and said second leg portion of each pair of said pairs of signal contacts being soldered to the reverse-surface-side pad of the respective pair of said pairs of signal pads, thus said plug being connected with said end of said junction substrate;
said plurality of sub-cables exposed from the end of said cable are equally separated into sub-cables on the obverse-surface side of said junction substrate and sub-cables on the reverse-surface side of said junction substrate, the pair of leads of each of said plurality of sub-cables being soldered to the respective pair of said pairs of lead connection pads, respectively; and
said shielding cover has shielding-plate portions at one end thereof and shielding-arm portions at the other end thereof, said shielding-plate portions being inserted into said plug and said shielding-arm portions being connected with said sub-cable shielding portion of said cable, thus said shielding cover being fastened to said plug and said cable.

7. A plug for balanced transmission, comprising:
a housing made of synthetic resin;
alternately arranged ground contacts and pairs of signal contacts; and
two shielding plates incorporated into said housing oppositely,
wherein:
each pair of said pairs of signal contacts has first and second leg portions between which an end of a printed-circuit board is inserted, the lengths of said first and second leg portions of each pair of said pairs of signal contacts being equal to one another;
each of said ground contacts has leg portions between which said end of said printed-circuit board is inserted; and
said two shielding plates have leg portions between which said end of said printed-circuit board is inserted.

8. A plug for balanced transmission, comprising:
a housing made of synthetic resin;
alternately arranged ground contacts and pairs of signal contacts; and
two shielding members incorporated into said housing oppositely,
wherein:
each pair of said pairs of signal contacts has first and second leg portions between which an end of a printed-circuit board is inserted, the lengths of said first and second leg portions of each pair of said pairs of signal contacts being equal to one another;
each of said ground contacts has leg portions between which said end of said printed-circuit board is inserted; and
said two shielding members have shielding-plate portions which are inserted into said housing, and covering portions which cover said first and second leg portions of each pair of said pairs of signal contacts and said leg portions of each of said ground contacts when said shielding-plate portions are inserted into said housing.
